**Assessment of genetic variability for yield and quality traits in tomato *(Solanum lycopersicum* L.)**

**Abstract**

The present study was conducted to assess genetic parameters such as genetic variability, heritability, and genetic advance as a percent of the mean and the estimates of PCV were higher than GCV for all the traits in tomato (*Solanum lycopersicum* L.). The research involved the evaluation of 34 tomato genotypes during the 2023–24 growing season at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh. The analysis of variance (ANOVA) revealed highly significant differences among the genotypes for all 17 traits under observation. Among the traits, phenotypic coefficient of variation (PCV) exceeded the genotypic coefficient of variation (GCV) and highest phenotypic as well as genotypic coefficients of variation were observed in seven character i.e. lycopene content (41.96% and 41.76%) followed by fruit yield per plant (34.20% and 31.77%), fruit yield (q/ha) (33.34% and 31.04%), number of fruit per plant (31.19% and 28.86%), number of locule per fruit (28.09% and 27.39%), plant height (27.95% and 27.04%), pericarp thickness (25.24% and 24.39%). Very high estimates of heritability were recorded for fifteen characters i.e. lycopene content (99.02%) followed by TSS (96.79%), number of locule per fruit (95.08%), plant height (93.61%), pericarp thickness (93.35%), ascorbic acid (93.30%), titrable acidity (92.95%), etc. and combined with substantial genetic advance as a percent of the mean, were recorded for several traits including lycopene content (99.02% and 85.60%), total soluble solids – TSS (96.79% and 30.10%), number of locules per fruit (95.08% and 55.03%), plant height (93.61% and 53.90%), pericarp thickness (93.35% and 48.54%), ascorbic acid content (93.30% and 18.60%), titratable acidity (92.95% and 29.30%), etc. The occurrence of high heritability in conjunction with high genetic advance for these traits suggests that additive gene effects play a major role in their inheritance. We have to used Kashi Chayan as a check variety to compare our genotypes to find which genotypes performed better than the selected check variety, so as to make our selection easier. Consequently, these traits offer’s potential for effective improvement through simple phenotypic selection.

**Keywords:** Genetic Variability, Heritability, GCV, PCV, *Solanum lycopersicum* L

**Introduction**

Tomato (*Solanum lycopersicum* L., 2n=2X=24) belongs to the solanaceae family and the genus solanum. According to Muller (1940), the genus is categorized into two sub-genera: *Eulycopersicon* and *Eriopersicon*. Tomato is considered a day-neutral plant and it is either a short-lived perennial or an annual herbaceous species and predominantly self-pollinated. Although it is a perennial by nature, it is widely cultivated as an annual crop across the globe. Tomatoes are consumed both fresh and cooked and serve as the base for numerous processed products like juice, ketchup, puree, paste, syrup, and beverages (Hyman, C. 2019).

Nutritionally, tomatoes are rich in moisture and vital nutrients. A 100g portion of the edible fruit contains approximately 93.10g of water, 3.60g carbohydrates, 1.90g protein, 0.10g fat, 0.60g minerals, and 0.70g dietary fiber, along with a notable content of ascorbic acid (Nguyen and Schwartz, 1998). The total amino acid content ranges between 100 to 350 mg per 100g of fruit. According to (Diet and Fitness Today, 2024), it also offers beta-carotene, folate, vitamins A, C, and E, flavonoids, potassium, and various minerals. Vitamin C, present at around 20 mg per 100g, acts as a potent antioxidant. Owing to its rich nutritional profile and antioxidant properties, the tomato is often termed a "protective food." Lycopene, a carotenoid pigment, is primarily responsible for its red coloration (Britannica, 2024; Rao & Agarwal, 2000).

Exploitation of heterosis has long been recognized as an effective approach for improving tomato productivity, with early studies reporting yield advantages ranging from 20% to 50% (Chowdhury et al., 1965). In modern tomato breeding programs, the identification and use of genetically diverse parental lines remain crucial for harnessing such hybrid vigor. These diverse genotypes serve as reservoirs of valuable alleles that govern key agronomic traits, making them indispensable in the development of improved cultivars (Kouam *et al.,* 2018).

In crop improvement programs, especially for quantitative traits, understanding and exploiting genetic variability is crucial (Allard, 1960). Yield and its contributing traits must exhibit variability in the base population to achieve meaningful genetic gains. Moreover, the success of selection also depends on how heritable those traits are. However, heritability alone does not guarantee selection efficiency. It must be considered alongside the genetic advance to determine the potential for effective trait improvement (Johnson *et al.,* 1955).

**Material and Methods**

The site of investigation was Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) which is geographically located between 26.560 north latitude 81.840 east longitude. The altitude is about 113 meters above the mean sea level in the Gangetic Alluvial Plains of Eastern Uttar Pradesh. and field have sandy loam soil, low in organic matter, nitrogen, medium in phosphorous, potash, and slightly alkaline in nature with pH 8.5 and The climatic condition is semi-arid with cold winter and hot summer. Nearly 80% of total rainfall is received during the monsoon (only up to September) with a few showers in the winter. Maximum rains in this area are received from July to the end of September. The winter months are usually cool and dry but occasional light showers are also not uncommon.. The mechanical composition of soil was 60.9 percent sand, 27.8 per cent silt and 11.3 per cent clay.

Total 34 diverse tomato genotypes were collected and evaluated in randomized block design with three replications. The genotypes were analyzed and studied for 17 different parameters *viz,* Days to 50% flowering, Days to first fruit harvest, Polar fruit diameter (cm), Equatorial fruit diameter (cm), Number of locules per fruit, Pericarp thickness (mm), Average fruit weight (g), Number of fruits per plant, Number of primary branches per plant, Plant height (cm), Fruit yield per plant (g), Fruit yield (q/ha), TSS (º Brix), Lycopene content (mg/100g), β-carotene (mg/100g), Titrable acidity (%), Ascorbic acid (mg/100g).

**Table 1: Genotypes and their source:-**

|  |  |  |
| --- | --- | --- |
| **SI. NO.** | **Genotypes** | **Source** |
|  | NDT-23-1 | Varanasi |
|  | NDT-23-2 | Ayodhya |
|  | NDT-23-3 | Locally |
|  | NDT-23-4 | Lucknow |
|  | NDT-23-5 | Varanasi |
|  | NDT-23-6 | Varanasi |
|  | NDT-23-7 | Locally |
|  | NDT-23-8 | Ayodhya |
|  | NDT-23-9 | Varanasi |
|  | NDT-23-10 | Locally |
|  | NDT-23-11 | Ayodhya |
|  | NDT-23-12 | Ayodhya |
|  | NDT-23-13 | Varanasi |
|  | NDT-23-14 | Ayodhya |
|  | NDT-23-15 | Varanasi |
|  | NDT-23-16 | Locally |
|  | NDT-23-17 | Ayodhya |
|  | NDT-23-18 | Varanasi |
|  | NDT-23-19 | Locally |
|  | NDT-23-20 | Locally |
|  | NDT-23-21 | Varanasi |
|  | NDT-23-22 | Varanasi |
|  | NDT-23-23 | Locally |
|  | NDT-23-24 | Locally |
|  | NDT-23-25 | Ayodhya |
|  | NDT-23-26 | Varanasi |
|  | NDT-23-27 | Ayodhya |
|  | NDT-23-28 | Varanasi |
|  | NDT-23-29 | Ayodhya |
|  | NDT-23-30 | Varanasi |
|  | NDT-23-31 | Ayodhya |
|  | NDT-23-32 | Locally |
|  | NDT-23-33 | Ayodhya |
|  | Kashi Chayan (Check) | Varanasi |

The mean values of data were subjected to the analysis of variance as per the procedure described by Panse and Sukhatme (2000). The genotypic and phenotypic co-efficient of variation were calculated as per formulae given by Burton and De-Vane (1953). Heritability and genetic advance were according to Allard (1960) and genetic gain was estimated as per the method given by Johnson *et al.,* (1955).

**Results and discussion**

In the present investigation, analysis of variance was calculated for 17 characters. The analysis of variance revealed highly significant difference among 34 genotypes for all 17 characters (Table 2). A wide range of variability was observed for different quantitative traits indicating the scope for selection of suitable initial breeding material for further improvement. The mean performance of different genotypes as given in (Table 3) revealed a wide range of variability for all the traits under study *viz.,* Days to 50 % flowering (29 to 36 days), Days to first fruit harvest (78 to 87.67 days), Polar fruit diameter (3.07cm to 5.97cm), Equatorial fruit diameter (3.10cm to 6.90cm), Number of locules per fruit (2.80 to 8.30), Pericarp thickness (2.11mm to7.91mm), Average fruit weight (42.13g to 110.13gm), Number of fruits per plant (7 to 30.67), Number of primary Branches /plant (3.33 to 6.67), Plant height (41.03cm to 130.47cm), TSS (3.070Brix to 5.870Brix), Lycopene content (0.75 to 4.33 mg/100 g), β- carotene (1.84 to 2.93 mg/100 g), Titrable acidity (0.32 to 0.57 %), Ascorbic acid ( 16.20 to 24.93 mg/100 g), Fruit yield /plant (657.30g to 2444.41g), Fruit yield (206.46 to 737.72 q/ha). Similar findings have been also reported by many workers Khuntia *et al.,* (2019), Prakash *et al.,* (2019) and Akhter *et al.,* (2021).

The analysis of components of variance (Table 4) revealed that phenotypic coefficients of variations (PCV) were higher than genotypic coefficients of variations (GCV) for all the characters. The highest phenotypic (>20%) as well as genotypic coefficients of variation were observed in the case of lycopene content (41.96% and 41.76%) followed by fruit yield per plant (34.20% and 31.77%), fruit yield (q/ha) (33.34% and 31.04%), number of fruits per plant (31.19% and 28.86%), number of locule per fruit (28.09% and 27.39%), plant height (27.95% and 27.04%), pericarp thickness (25.24% and 24.39%). Moderate (10-20%) estimates of PCV and GCV were estimated for polar fruit diameter (19.42% and 18.33%), average fruit weight (17.92% and 16.52%), number of primary branches per plant (17.63% and 16.17%), equatorial fruit diameter (17.50% and 16.31%), titrable acidity 15.30% and 14.75%), TSS (15.10% and 14.85%), β-carotene (12.85% and 11.90%). The phenotypic and genotypic coefficients of variations were lower (<10%) for ascorbic acid (9.68% and 9.35%), days to 50% flowering (6.61% and 4.29%) and days to first fruit harvest (3.73% and 2.92%), low GCV and PCV for these traits indicated that there was less variation for this trait.

Similar, results have been reported by Bhandari *et al.* (2017), they observed number of seed per fruit (PCV 36.38 % and GCV 35.22 %), total number of fruits per plant (PCV 35.84 % and GCV 35.37 %), Fruit yield (PCV 35.07 % and GCV 34.69 %), Average fruit weight (PCV 31.25 % and GCV 30.89 %), Number of locules per fruit (PCV 26.07 % and GCV 23.12 %), Number of fruit per cluster (PCV 23.32 % and GCV 21.36 %), Number of primary branches per plant (PVC 21.07 % and GCV 19.57 %), Number of flower per cluster (PCV 19.58 % and GCV 18.60 %), Plant height (PCV 18.18 % and GCV 16.85 %), Days to 50% flowering (PCV 12.06 % and GCV 9.65 %) and Ahmad *et al.* (2016), Lekshmi *et al*. (2017) and Khuntia *et al*. (2019) Prakash *et al.* (2019), Akhter *et al. (*2021).

Higher values for PCV than that of GCV suggesting that the characters are sensitive to environmental fluctuations. Thus, selection based on phenotypic performance of these characters would be ineffective to bring about considerable genetic improvement of these traits in the genotypes included in the present study.

The heritability in the broad sense ranged from 42.17% in the case of days to 50% flowering to 99.02% for lycopene content. Very high estimates of heritability (>80%) were recorded for fifteen characters i.e. lycopene content (99.02%) followed by TSS (96.79%), number of locule per fruit (95.08%), plant hight (93.61%), pericarp thickness (93.35%), ascorbic acid (93.30%), titrable acidity (92.95%), polar fruit diameter (89.10%), equatorial fruit diameter (86.85%), fruit yield (q/ha) (86.68%), fruit yield per plant (86.32%), β-carotene (85.72%), number of fruit per plant (85.59%), average fruit weight (84.96%), number of primary branch per plant (84.18%). However high heritability (60-80%) was recorded for one character *i.e*. days to first fruit harvest (61.31%) and moderate heritability (40-60%) was recorded for one character *i.e.* days to 50% flowering (42.17%) and there is not lower heritability (<40%) was recorded in estimated in all 17 characters.

The highest value of genetic advance in per cent of the mean was shown by lycopene content (85.60%) while days to first fruit harvest exhibited the lowest value (4.71%) for this parameter. Similar results were also reported by Cholin *et al.* (2021). They recorded high genetic advance as per cent of mean in average fruit weight (72.04 %) followed by lycopene (60.39 %), number of fruits per plant (57.23 %) while low genetic advance in per cent of mean found in days to first flowering (6.1 %) followed by days to 50 % flowering (6.64 %), TSS (10.27 %) and fruit per cluster (10.48 %).

High heritability coupled with high genetic advance in per cent of mean were recorded for lycopene content (99.02% and 85.60%), TSS (96.79% and 30.10%), number of locule per fruit (95.08% and 55.03%), plant height (93.61% and 53.90%), pericarp thickness (93.35% and 48.54%), ascorbic acid (93.30% and 18.60%), titrable acidity (92.95% and 29.30%), polar fruit diameter (89.10% and 35.65%), equatorial fruit diameter (86.85% and 31.31%), fruit yield (q/h) (86.68% and 59.53%), fruit yield per plant (86.32% and 60.81%), β-carotene (85.72% and 22.70%), number of fruit per plant (85.59% and 55.00%), average fruit weight (84.96% and 31.37%), number of primary branch per plant (84.18% and 30.57%), days to first fruit harvest (61.31% and 4.71%) and days to 50% flowering (42.17% and 5.74%) indicating that these traits were little influenced by environment. Thus, it requires low selection intensity for improvement.

Similar results were also reported by Cholin *et al*. (2021). High heritability coupled with high genetic advance in per cent of mean were recorded for polar diameter (95.4 % and 42.66 %), average fruit weight (94.3 % and 72.04 %), fruit firmness (94.3 % and 26.24 %), fruit pH (91.4 % and 31.99 %), plant spread (84.8 % and 27.07 %) indicating that these traits were little influenced by environment and Sajjan *et al.* (2016), Bhandari *et al*., (2017) and Singh *et al.* (2020). Thus, it requires low selection intensity for improvement.

**Table 2. Analysis of variance (mean squares) for seventeen quantitative characters in tomato.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Replication** | **Treatment** | **Error** | **Total** |
| DF | 2 | 33 | 66 | 101 |
| Days to 50% Flowering | 0.21 | 8.45\*\* | 2.65 | 4.50 |
| Days to First Fruit Harvest | 7.57 | 21.06\*\* | 3.66 | 9.42 |
| Polar Fruit Diameter (cm) | 0.030 | 2.235\*\* | 0.088 | 0.788 |
| Equatorial Fruit Diameter (cm) | 0.003 | 2.244\*\* | 0.108 | 0.804 |
| No. of Locules per Fruit | 0.062 | 5.275\*\* | 0.089 | 1.783 |
| Pericarp Thickness (mm) | 0.003 | 4.260\*\* | 0.099 | 1.457 |
| Average Fruit Weight (g) | 4.33 | 635.08\*\* | 35.39 | 230.71 |
| No. of Fruits per Plant | 2.25 | 76.08\*\* | 4.04 | 27.54 |
| No. of Primary Branches per Plant | 0.02 | 2.34\*\* | 0.14 | 0.85 |
| Plant Height (cm) | 8.28 | 1483.06\*\* | 32.97 | 506.28 |
| Fruit Yield per Plant (g) | 18305.46 | 640104.55\*\* | 32125.75 | 230498.62 |
| Fruit Yield (q/ha) | 1593.12 | 56821.76\*\* | 2769.73 | 20406.99 |
| TSS (0 Brix) | 0.05 | 1.47\*\* | 0.02 | 0.49 |
| Lycopene Content (mg/100 g) | 0.010 | 2.392\*\* | 0.008 | 0.787 |
| β-Carotene (mg/100 g) | 0.014 | 0.269\*\* | 0.014 | 0.097 |
| Titratable Acidity (%) | 0.000 | 0.013\*\* | 0.000 | 0.004 |
| Ascorbic Acid (mg/100 g) | 1.11 | 11.37\*\* | 0.27 | 3.91 |

\*\* Significant at 1% level

\* Significant at 5% level

**Table 3:- The mean performance, general means and range of thirty-four entries for seventeen characters.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Traits** | **Days to 50 % flowering** | **Days to first fruit harvest** | **Polar fruit diameter (cm)** | **Equatorial fruit diameter (cm)** | **No. of locules per fruit** | **Pericarp thickness (mm)** | **Average fruit weight (g)** | **No. of fruits per plant** | **No. of pri. Br. /plant** | **Plant height (cm)** | **TSS (0 Brix)** | **Lycopene content (mg/100 g)** | **β- carotene (mg/100 g)** | **Titrable acidity (%)** | **Ascorbic acid (mg/100 g)** | **Fruit yield /plant (g)** | **Fruit yield (q/ha)** |
| 1 | NDT-23-1 | 35.33 | 86.67 | 4.37 | 5.20 | 6.30 | 4.26 | 98.27 | 16.33 | 6.67 | 93.13 | 4.23 | 3.17 | 2.23 | 0.35 | 20.20 | 1608.96 | 481.21 |
| 2 | NDT-23-2 | 33.00 | 82.67 | 4.73 | 3.10 | 3.17 | 3.24 | 42.13 | 16.33 | 5.67 | 41.03 | 4.37 | 1.17 | 2.07 | 0.41 | 18.33 | 657.30 | 206.46 |
| 3 | NDT-23-3 | 31.67 | 86.33 | 5.00 | 5.40 | 6.30 | 3.31 | 98.00 | 15.00 | 5.33 | 130.47 | 5.87 | 2.17 | 2.50 | 0.47 | 20.47 | 1357.62 | 441.58 |
| 4 | NDT-23-4 | 32.67 | 84.00 | 3.07 | 4.20 | 3.47 | 5.39 | 87.33 | 27.00 | 6.00 | 60.08 | 4.27 | 1.67 | 2.84 | 0.37 | 24.17 | 2444.41 | 707.89 |
| 5 | NDT-23-5 | 32.33 | 80.67 | 3.70 | 5.60 | 6.07 | 4.32 | 95.53 | 16.67 | 3.67 | 77.00 | 4.77 | 2.43 | 2.33 | 0.57 | 21.40 | 1573.71 | 477.42 |
| 6 | NDT-23-6 | 30.67 | 82.00 | 4.87 | 4.20 | 3.53 | 4.25 | 57.00 | 18.33 | 5.67 | 94.43 | 4.40 | 2.73 | 2.93 | 0.40 | 23.63 | 994.63 | 314.52 |
| 7 | NDT-23-7 | 31.33 | 87.67 | 4.74 | 5.80 | 4.57 | 4.81 | 68.18 | 15.67 | 5.00 | 88.33 | 4.33 | 2.27 | 2.01 | 0.34 | 21.33 | 1055.01 | 319.81 |
| 8 | NDT-23-8 | 33.67 | 85.67 | 4.45 | 5.20 | 5.03 | 5.10 | 107.13 | 7.00 | 4.00 | 56.63 | 4.27 | 3.17 | 2.77 | 0.43 | 19.50 | 779.10 | 224.37 |
| 9 | NDT-23-9 | 32.67 | 86.67 | 3.24 | 4.20 | 2.80 | 5.25 | 68.50 | 15.00 | 5.00 | 78.87 | 4.93 | 1.07 | 2.53 | 0.44 | 20.10 | 955.52 | 308.16 |
| 10 | NDT-23-10 | 33.67 | 79.67 | 4.04 | 5.03 | 5.31 | 7.19 | 94.34 | 14.00 | 3.33 | 89.77 | 5.63 | 3.17 | 2.67 | 0.41 | 19.40 | 1266.75 | 396.80 |
| 11 | NDT-23-11 | 29.00 | 81.33 | 4.73 | 5.30 | 4.17 | 6.09 | 86.13 | 14.33 | 5.33 | 78.07 | 5.87 | 1.53 | 2.54 | 0.43 | 20.10 | 1169.14 | 370.10 |
| 12 | NDT-23-12 | 34.33 | 82.67 | 5.41 | 6.20 | 6.20 | 5.46 | 89.53 | 13.67 | 5.67 | 96.38 | 4.27 | 0.92 | 2.17 | 0.34 | 20.20 | 1251.89 | 367.74 |
| 13 | NDT-23-13 | 32.33 | 81.67 | 5.81 | 6.90 | 5.03 | 4.23 | 96.17 | 16.00 | 6.33 | 103.58 | 5.17 | 2.74 | 1.84 | 0.47 | 19.40 | 1466.34 | 461.97 |
| 14 | NDT-23-14 | 32.33 | 83.33 | 4.27 | 5.80 | 8.30 | 4.23 | 97.37 | 14.67 | 4.67 | 89.74 | 4.67 | 2.73 | 2.77 | 0.40 | 18.17 | 1487.99 | 428.34 |
| 15 | NDT-23-15 | 34.67 | 80.67 | 5.87 | 6.20 | 3.24 | 5.18 | 87.33 | 13.67 | 5.00 | 109.99 | 5.37 | 3.17 | 2.74 | 0.54 | 19.93 | 1145.81 | 357.66 |
| 16 | NDT-23-16 | 32.67 | 85.67 | 4.24 | 5.03 | 3.91 | 3.11 | 86.93 | 27.00 | 6.33 | 85.22 | 5.23 | 2.87 | 2.47 | 0.32 | 22.80 | 2353.71 | 703.36 |
| 17 | NDT-23-17 | 31.67 | 83.67 | 3.10 | 4.20 | 4.74 | 4.53 | 100.20 | 14.33 | 5.33 | 99.62 | 5.00 | 2.20 | 2.47 | 0.49 | 24.93 | 1378.89 | 431.67 |
| 18 | NDT-23-18 | 34.33 | 84.00 | 3.14 | 6.30 | 5.90 | 7.91 | 110.13 | 22.33 | 3.67 | 104.89 | 5.17 | 1.63 | 2.18 | 0.48 | 22.60 | 2330.90 | 737.72 |
| 19 | NDT-23-19 | 32.00 | 86.00 | 5.97 | 5.40 | 4.83 | 4.20 | 97.17 | 14.00 | 5.00 | 78.82 | 4.37 | 0.75 | 2.47 | 0.37 | 20.10 | 1293.95 | 407.76 |
| 20 | NDT-23-20 | 35.33 | 78.67 | 5.64 | 5.30 | 5.14 | 5.10 | 89.83 | 19.33 | 5.00 | 100.20 | 4.23 | 1.27 | 2.67 | 0.45 | 21.40 | 1810.92 | 521.73 |
| 21 | NDT-23-21 | 30.67 | 78.67 | 4.23 | 6.20 | 6.77 | 5.23 | 89.00 | 18.00 | 4.67 | 56.49 | 4.97 | 1.17 | 2.38 | 0.50 | 20.13 | 1667.43 | 479.94 |
| 22 | NDT-23-22 | 33.00 | 81.00 | 5.07 | 5.10 | 4.97 | 4.29 | 87.00 | 15.33 | 4.33 | 50.80 | 5.23 | 1.93 | 2.45 | 0.43 | 18.77 | 1285.26 | 401.02 |
| 23 | NDT-23-23 | 30.33 | 80.67 | 4.14 | 4.20 | 3.31 | 3.16 | 68.77 | 11.33 | 6.67 | 76.65 | 5.13 | 2.97 | 2.87 | 0.43 | 21.93 | 780.21 | 233.30 |
| 24 | NDT-23-24 | 31.33 | 79.67 | 3.14 | 3.80 | 3.17 | 3.82 | 84.23 | 14.33 | 6.33 | 65.43 | 5.87 | 2.17 | 2.44 | 0.37 | 20.97 | 1154.27 | 361.79 |
| 25 | NDT-23-25 | 33.67 | 78.00 | 4.27 | 4.60 | 3.88 | 2.11 | 62.80 | 30.67 | 4.67 | 56.19 | 3.43 | 1.27 | 2.18 | 0.53 | 16.20 | 1772.86 | 576.84 |
| 26 | NDT-23-26 | 29.33 | 81.67 | 5.85 | 5.90 | 4.07 | 5.42 | 85.97 | 22.33 | 6.33 | 52.27 | 3.07 | 1.37 | 1.94 | 0.41 | 18.17 | 1988.53 | 576.27 |
| 27 | NDT-23-27 | 31.33 | 81.67 | 5.58 | 4.30 | 4.82 | 6.83 | 65.37 | 20.33 | 4.67 | 104.28 | 5.23 | 3.27 | 1.88 | 0.38 | 19.30 | 1316.10 | 399.09 |
| 28 | NDT-23-28 | 30.33 | 85.00 | 5.44 | 4.00 | 4.90 | 5.34 | 94.13 | 13.67 | 6.33 | 68.30 | 4.63 | 3.37 | 2.70 | 0.43 | 18.97 | 1222.43 | 386.02 |
| 29 | NDT-23-29 | 31.33 | 78.33 | 4.21 | 5.30 | 2.80 | 5.29 | 96.50 | 20.33 | 5.67 | 44.58 | 4.13 | 1.43 | 2.36 | 0.54 | 19.47 | 2045.60 | 588.66 |
| 30 | NDT-23-30 | 31.67 | 83.00 | 5.00 | 5.60 | 3.61 | 4.21 | 86.87 | 15.00 | 6.33 | 55.03 | 3.23 | 1.53 | 2.55 | 0.49 | 19.63 | 1251.51 | 390.50 |
| 31 | NDT-23-31 | 31.33 | 81.67 | 5.36 | 5.90 | 6.84 | 6.28 | 77.97 | 11.67 | 5.33 | 65.92 | 4.10 | 4.33 | 2.37 | 0.46 | 20.73 | 914.07 | 273.79 |
| 32 | NDT-23-32 | 31.67 | 79.67 | 4.31 | 5.40 | 6.37 | 5.18 | 82.47 | 12.33 | 5.67 | 107.47 | 4.17 | 0.83 | 2.80 | 0.49 | 24.00 | 973.44 | 305.16 |
| 33 | NDT-23-33 | 33.33 | 82.67 | 5.37 | 6.30 | 4.98 | 5.12 | 85.63 | 26.00 | 4.67 | 98.73 | 4.80 | 2.27 | 2.28 | 0.44 | 19.97 | 2054.60 | 668.40 |
| 34 | Kashi Chayan (KC) | 36.00 | 84.00 | 4.55 | 4.77 | 4.67 | 4.74 | 86.00 | 15.33 | 5.67 | 105.90 | 5.23 | 1.87 | 2.86 | 0.55 | 23.37 | 1363.56 | 395.33 |
|  | Mean | **32.38** | **82.51** | **4.62** | **5.17** | **4.80** | **4.83** | **85.59** | **16.98** | **5.29** | **81.30** | **4.70** | **2.13** | **2.45** | **0.44** | **20.58** | **1416.84** | **432.42** |
|  | Min | 29.00 | 78.00 | 3.07 | 3.10 | 2.80 | 2.11 | 42.13 | 7.00 | 3.33 | 41.03 | 3.07 | 0.75 | 1.84 | 0.32 | 16.20 | 657.30 | 206.46 |
|  | Max | 36.00 | 87.67 | 5.97 | 6.90 | 8.30 | 7.91 | 110.13 | 30.67 | 6.67 | 130.47 | 5.87 | 4.33 | 2.93 | 0.57 | 24.93 | 2444.41 | 737.72 |
|  | SE(d) | 1.33 | 1.56 | 0.24 | 0.27 | 0.24 | 0.26 | 4.86 | 1.64 | 0.30 | 4.69 | 0.10 | 0.07 | 0.10 | 0.01 | 0.42 | 146.35 | 42.97 |
|  | C.D. | 2.66 | 3.13 | 0.48 | 0.54 | 0.49 | 0.51 | 9.72 | 3.29 | 0.61 | 9.38 | 0.21 | 0.15 | 0.19 | 0.03 | 0.84 | 292.86 | 85.99 |
|  | C.V. | 5.03 | 2.32 | 6.41 | 6.35 | 6.23 | 6.51 | 6.95 | 11.84 | 7.01 | 7.06 | 2.71 | 4.15 | 4.86 | 4.02 | 2.50 | 12.65 | 12.17 |

**Table 4. Estimates of range, grand mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), genetic advance in per cent of mean for seventeen characters in tomato germplasm.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **Mean** | **Range** |  | **GCV (%)** | **PCV (%)** | **Heritability (%)** | **GA% mean** |
| **D50F** | 32.38 | 29.00 | 36.00 | 4.29 | 6.61 | 42.17 | 5.74 |
| **DFFH** | 82.51 | 78.00 | 87.67 | 2.92 | 3.73 | 61.31 | 4.71 |
| **PFD** | 4.62 | 3.07 | 5.97 | 18.33 | 19.42 | 89.10 | 35.65 |
| **EFD** | 5.17 | 3.10 | 6.90 | 16.31 | 17.50 | 86.85 | 31.31 |
| **NLF** | 4.80 | 2.80 | 8.30 | 27.39 | 28.09 | 95.08 | 55.03 |
| **PT** | 4.83 | 2.11 | 7.91 | 24.39 | 25.24 | 93.35 | 48.54 |
| **AFW** | 85.59 | 42.13 | 110.13 | 16.52 | 17.92 | 84.96 | 31.37 |
| **NFP** | 16.98 | 7.00 | 30.67 | 28.86 | 31.19 | 85.59 | 55.00 |
| **NPBP** | 5.29 | 3.33 | 6.67 | 16.17 | 17.63 | 84.18 | 30.57 |
| **PH** | 81.30 | 41.03 | 130.47 | 27.04 | 27.95 | 93.61 | 53.90 |
| **TSS** | 4.70 | 3.07 | 5.87 | 14.85 | 15.10 | 96.79 | 30.10 |
| **LC** | 2.13 | 0.75 | 4.33 | 41.76 | 41.96 | 99.02 | 85.60 |
| **b-CARO** | 2.45 | 1.84 | 2.93 | 11.90 | 12.85 | 85.72 | 22.70 |
| **TA** | 0.44 | 0.32 | 0.57 | 14.75 | 15.30 | 92.95 | 29.30 |
| **AA** | 20.58 | 16.20 | 24.93 | 9.35 | 9.68 | 93.30 | 18.60 |
| **FYP (g)** | 1416.84 | 657.30 | 2444.41 | 31.77 | 34.20 | 86.32 | 60.81 |
| **FYH (q)** | 432.42 | 206.46 | 737.72 | 31.04 | 33.34 | 86.68 | 59.53 |

**Conclusion**

The result of current experiment revealed that all character is highly significant. The genotype., NDT-23-18 (737.72) followed by NDT-23-4 (707.89), NDT-23-16 (703.36), NDT-23-33 (668.40) and NDT-23-29 (588.66) were found significant against total fruit yield per plant of the check Kashi Chayan (395.33) so this can be using as promising cultivar in further studies. The highest phenotypic as well as genotypic coefficients of variation were observed in the case of lycopene content (41.96% and 41.76%) followed by fruit yield per plant (34.20% and 31.77%), fruit yield (q/ha) (33.34% and 31.04%), number of fruits per plant (31.19% and 28.86%), number of locule per fruit (28.09% and 27.39%), plant height (27.95% and 27.04%), pericarp thickness (25.24% and 24.39%). Very high estimates of heritability were recorded for fifteen characters i.e. lycopene content (99.02%) followed by TSS (96.79%), number of locule per fruit (95.08%), plant hight (93.61%), pericarp thickness (93.35%), ascorbic acid (93.30%), titrable acidity (92.95%), polar fruit diameter (89.10%), equatorial fruit diameter (86.85%), fruit yield (q/ha) (86.68%), fruit yield per plant (86.32%), β-carotene (85.72%), number of fruit per plant (85.59%), average fruit weight (84.96%), number of primary branch per plant (84.18%). The highest value of genetic advance in per cent of the mean was shown by lycopene content (85.60%) while days to first fruit harvest exhibited the lowest value (4.71%) for this parameter.

1. Based on the findings of the experiment conducted, genotype NDT-23-18 was found to be superior among all the genotypes for yield and genotype NDT-23-31 found to be superior in lycopene content. Thus, these cultivars might be used in further breeding program to obtain desirable result.

**Disclaimer (Artificial intelligence)**

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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2.

3.

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